

February 27, 2018: Comments and background information on Excelsior Gunnison in-situ copper mine water issues for US EPA Region 9 draft Underground Injection Control (UIC) permit hearing, Dragoon, Arizona.

by

Richard Kamp for the Amerind Foundation, which is an active research and educational center, museum, and art gallery for thousands of Arizonans, preserving thousands of irreplaceable archeological artifacts and Indigenous objects and art in its museum located in Texas Canyon just west of the proposed mine site. The foundation has two wells located by the municipal wells of Dragoon and is vulnerable to potential groundwater contamination impacts from the Gunnison project (see map). Amerind has submitted its own and joint comments with six other organizations constituting an environmental coalition for the February 27 hearing, and previously in January regarding this permit. At the end of this summary are references to specific documents that can provide those interested with far more information. This brief summary is by Richard Kamp, Director of nonprofit E-Tech International. Any errors or opinions are his. E-Tech provides environmental technical support internationally to Indigenous and other communities requesting assistance in addressing potential or actual impacts from large-scale industry and works closely with governmental, academic, civil society, and industry professional groups to do so. Since this is not an international issue, E-Tech is not represented by these comments.

What are potential groundwater contamination risks from the Gunnison mine? Excelsior mining is attempting to permit the first commercial scale in-situ sulfuric acid injected copper mine in the U.S. and perhaps globally. The Gunnison Project is the first mining investment for Vancouver, BC-based Excelsior and whether they mine or sell their private property, equipment and permits to another mining company, the permitting requirements will remain the same. Another attempt to permit an in-situ copper mine in Florence, Arizona, remains on hold. Old and polluted copper mine sites in Arizona have utilized in-situ extraction to access difficult deposits and experiments with various in-situ technologies for many decades. Pilot in-situ new copper projects were at first greeted with cautious optimism by a few environmentalists. Pluses: Limited waste and tailings, no pit and minimal surface disruption, and use of solvent-extraction electrowinning (SX-EW), which although energy intensive is a good means to create cathode copper through electrical currents passing through a solution containing acidically leached copper from any source—new, waste or old deposits.

Minuses: In-situ uranium mines throughout the world, using alkaline- as well as acidic as in the Gunnison project- solutions to leach uranium have a history of leaving extensive groundwater polluted and unable to remediate back to baseline levels of potability. This scenario is in spite of the fact that some uranium mines argued that the use of alkaline solutions would impact groundwater less than in-situ acid technologies such as proposed for Gunnison.

Applying the technology of acidic injection to copper in Dragoon poses major questions: what can be done to prevent contamination? What are the contaminants since this is a copper sulfide body and not uranium? How can they be remediated? What is the geohydrology of the ore body and groundwater within the surrounding wells; an Amerind concern with two 700-foot deep wells located 3 miles south of the mine field boundary in the town of Dragoon, and near the municipal water company wellfield.

Due to the geology of ore bodies, Southern Arizona copper mines have a history of releasing radioactive substances (although less than uranium mine pollution “plumes”) and certain heavy metals into groundwater. These may be naturally part of the ore body but are released usually by acidity from mining activity. These “radionuclides”, called TENORMs by US EPA and Arizona

Department of Environmental Quality (ADEQ), include uranium, radium, and decaying radioactive substances. For example, in the late 1970s Phelps Dodge wanted to start a yellowcake uranium leach facility in Bisbee, which was battled by the community. By the late 1980s, radionuclides were part of a groundwater pollution plume extending south of the Bisbee tailings dumps that now belong to Freeport. Similarly, at different large minesites in southern Arizona, one finds sulfates, radionuclides and heavy metals including copper, zinc, cadmium, manganese, arsenic and other contaminants in groundwater contamination from mineshafts, pits, overburden, wasteponds and tailings. Such contaminants entered the water table either while mining occurred or post-closure as aquifers rose when pumping stopped. The same constituents may be of concern to monitor at Gunnison coupled with other chemicals that will be specifically used in the injection process as well as at the Johnson Mine SX-EW plant. Some of the in-situ chemicals are proprietary but they all must be monitored regularly: in pregnant leach solution, water treatment plant effluent, evaporation and drain ponds, raffinate pond, the recycled water pond, and any runoff from the Sx-ew plant-these are sources of pollution related to and sometimes beyond what is actually injected into the ground.

Determining the source of pollution for a monitored exceedance at Gunnison in any circumstance beyond an obvious surface spill a (common problem with uranium in-situ) will be difficult. For example: which of 1434 wells that are up to 1400 feet deep and injecting up to 25,600 gallons per minute of acid solution into the ground at a pressure rate that is unknown could be responsible for an exceedance of water quality standards? Excelsior consultant Clear Creek Associates suggested that the solution to be reinjected and recycled repeatedly for injection at unknown pressure would contain concentrations of cadmium, lead, selenium, nickel, thallium, zinc, and fluoride, among others, at much higher than background or baseline pollution levels and most water quality standards. Many of these metals would be contaminants picked up from the ground from previous injection after copper was removed for SX-EW processing.

Groundwater pollution migration questions: The ore deposits to be leached through in-situ injection are fractured and broken up (permeable) and that is why they are exploitable for copper. That means that unless Excelsior can demonstrate—as they claim they have—that the groundwater containing pollution cannot migrate from the site then they may be creating a pollution problem. Reporter Eric Petermann of the Sierra Vista Herald (6/28/17) wrote that Excelsior CEO Steve “Twyerould said the geology of the area where the Gunnison Mining Project is being developed is ideal for the process. It’s one of just a few places around the world that has permeable bedrock, surrounded by limestone, with a groundwater flow that slopes toward the Willcox Playa, not the populated and environmentally-sensitive Dragoons and San Pedro Subwatershed.” The mine must demonstrate to EPA and ADEQ that the groundwater contamination cannot migrate offsite—even if it slopes toward Willcox Playa and not Dagoon.

In his January analysis submitted to Region 9 EPA hydrogeologist Tom Myers summarized the very serious scientific discrepancies in Excelsior’s claim that any groundwater will be limited to the site, remediated and cleaned upon closure, within a hydrological flow only to the east and north. He analyzed what he felt was missing in the Clear Creek Associates groundwater models and said in an interview, “Regarding the possibility of contaminated groundwater flowing south toward Dagoon, there is insufficient information on the number of fractures at the site, and even if the natural gradient of flow doesn’t head toward Dagoon, the mine will or can change the natural gradient during the drilling of over 1430 boreholes and many recovery wells.. If there are fractures in the so-called neutralizing protective and impermeable limestone- then contamination could go to Dagoon. The limestone would have to be in contact with all of the contaminated acid in order to effectively neutralize it and that is very difficult to demonstrate. Furthermore, the injection wells will push acid

into the ground under pressure and it will “mound” acid in the water table on site. The dynamic between the “recovery wells” and the injection sites at the mine is not explained by Excelsior. Supposedly, interceptor wells on the perimeter of the site are supposed to pump out any contamination before it leaves the site but experience tells us that this does not always work at mines (see last section). That is why we (coalition members) are asking for a lot more monitoring before and during operation as well as post-closure. There is a lot of uncertainty in modeling and we never know how wells will behave, or if they will fail, which I addressed in my submittal to EPA.” Myers report is called “Technical Memorandum Review of Underground Injection Control Permit and Application Gunnison Copper Project” January 6, 2018. For a copy of Myers study or other Gunnison Project environmental coalition comments contact (b)(6)/Privacy Act

Legal/regulatory options to protect Dragoon Groundwater from Gunnison Project

The ADEQ Aquifer Protection Permit program (Gunnison now has an APP and it has not been appealed) and the EPA Underground Injection Control (UIC) permit are the regulatory tools applicable to this mine and SX-EW site. The state has required a \$9.524 million closure and post-closure bond to “return the site to original groundwater and surface conditions.” EPA has issued a bond requirement of \$8.792 million, and neither agency has offered a justification for the amounts given that we may be talking remediation in perpetuity. In Arizona, contamination is not permitted to migrate offsite. Other states have laws that are stronger: some require protection of groundwater below a minesite, or in the case of Colorado rigorous protection from in-situ mining. Closure bonds for non in-situ mining are generally much higher than \$9 million, perhaps because surface infrastructure is greater, however the APP and UIC permits regulate groundwater protection and potential closure and post-closure costs for Gunnison.

If EPA issues an UIC permit for the Gunnison in-situ acid project it will be the first acid in-situ mine to receive that approval. A UIC permit applied for federally through the EPA for uranium mining at the South Dakota Dewey-Burdock injection permit for a uranium in-situ mine has now been in contention for around nine years. The Nuclear Regulatory Commission (NRC), who regulates uranium mines, issued the first license for a sulfuric acid in-situ uranium mine just this January; in the U.S. these acid in-situ mines are new although they have been utilized for uranium in Europe

States can issue UIC permits if they receive approval from EPA to do so. The Arizona House in late February passed a bill now on the way to the state senate that will create a regulatory structure to implement UIC permits through the Arizona government. This is known as “state primacy” and supported by Governor Ducey. Should this become state law, as is probable, then EPA Region 9 will need to determine what is needed to approve an Arizona UIC exemption process instead of reviewing UIC permits themselves. It might be conjectured that an Arizona UIC process, like an APP process is now, could be limited to 180 days to be completed (in theory). An Arizona UIC could lack some legal requirements accompanying a federally issued permit. The Gunnison Project could theoretically end up before a state of Arizona ADEQ UIC process if the EPA UIC process were still underway by the time that EPA Region 9 approved Arizona state primacy to issue UIC permits. Failure of a Federal regulatory agency to meet requirements of UIC can be grounds for a court case. On the other hand, the state of Arizona’s legal liability may be much different from a Federal agency.

In the event of on-site groundwater contamination, can it be monitored and remediated? The evidence of effective remediation in the case of in-situ contamination is not very encouraging (USGS 2009: “To date, no remediation of an (in-situ) ISR operation in the United States has successfully returned the aquifer to baseline conditions.”) One strategy to address Gunnison contamination as it

potentially appears was proposed by the above-mentioned coalition in January: Greatly expand the scope and timing of monitoring, and create a multisector committee that would constantly oversee and respond to monitoring data from the mine and an independent lab. If pollution were to rise above baseline levels the group “shall meet immediately if and when this occurs to discuss the specific nature of the baseline deviation, and what may be the cause of it. If the exceedance continues for six months, Excelsior must cease all injection operations, or, if the problem appears to be local and specific to monitoring wells next to liquids storage facilities, those facilities shall be drained and repaired immediately.” In supplemental comments submitted February 26, 2018, the same coalition demanded that EPA repeat the “cumulative impacts” study—which is equivalent to a NEPA—National Environmental Policy Act—exhaustive environmental impact process that was utilized for the only other UIC permit the agency has been overseeing in South Dakota—as required by law.

How to remediate if the mine does pollute on site, to prevent it polluting off-site, is difficult. Geochemist and mining expert Dr. Ann Maest suggests “.Fractured bedrock is...a major challenge to monitor and remediate. There are some novel approaches for containing contamination in aquifers generally, including creating a frozen zone in a cylinder around the contaminant source, but that and others are still experimental. The tried...approach is still ‘pump and treat’, which is what Excelsior is doing. However, a ring of pumping wells would be needed around the plume (which would be difficult to identify the exact dimensions of because of the fractured bedrock) to gain hydrologic control of the plume. (interceptor wells are planned to pump and treat on the property where Excelsior projects groundwater to travel). (Injecting) a basic solution (e.g., sodium hydroxide) to neutralize the acid and hopefully precipitate out some of the metal... would still be a pump and treat remediation (that) only limits the extent of the plume (rather than) eliminating the plume completely. Depending on how far the plume escaped and other factors (mentioned by Myers)... one might be able to gain hydrologic control over the plume, but it could be a perpetual pump-and-treat situation (otherwise) groundwater flows very slowly, and returning to baseline conditions... would likely take thousands of years or longer.”

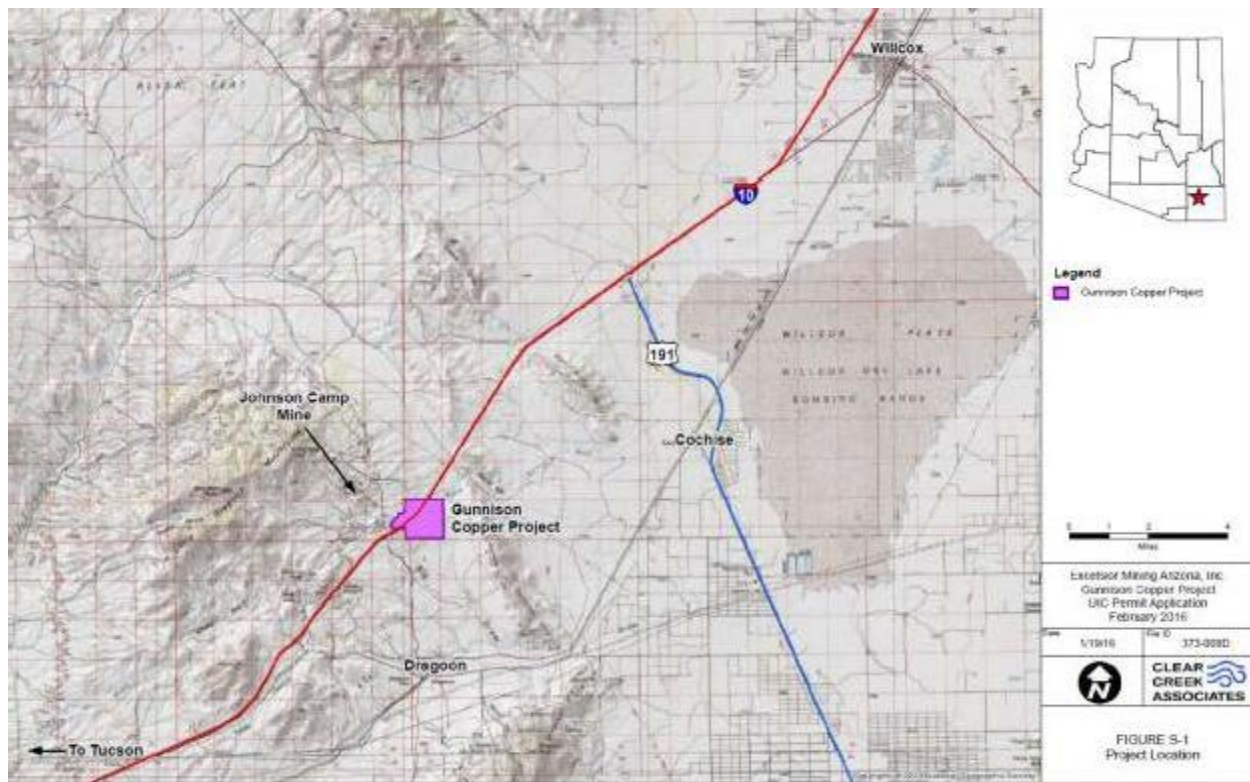
The word” perpetual” pump and treat raises obvious fears: who will do so for centuries if needed and what will the real expenses be?

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Ellen Cohen, Dragoon Conservation Alliance: (b)(6)/Privacy Act

Roger Featherstone, Arizona Mining Reform Coalition: (b)(6)/Privacy Act



GUNNISON MINE PROJECT FROM EXCELSIOR MINING SUBMISSION TO USEPA.

Further reading:

A. Documents on Excelsior Mining Gunnison Project:

1. www.excelsiormining.com
2. 2017-18 regulatory agency comments, supplementary comments, reference documents from the seven environmental coalition groups concerned with Gunnison Project are available from (b)(6)/Privacy Act. The groups are Drought Conservation Alliance | Amerind Foundation | Earthworks | Center for Biological Diversity | Patagonia Area Resource Alliance | Arizona Mining Reform Coalition | Sierra Club
3. All documents related to record of decision and amendments for EPA Region 9 UIC permit <https://www.epa.gov/uic/excelsior-mining-arizona-inc-gunnison-copper-project-draft-class-iii-uic-area-permit-and>
4. Arizona Mining Reform <http://www.azminingreform.org/content/attend-public-meeting-stop-proposed-gunnison-copper-mine>
5. Arizona Department of Environmental Quality Aquifer Protection Permit <http://www.azdeq.gov/public-notice-decision-issue-individual-app-gunnison-copper-project>

B. Some Selected Documents on In-Situ mining (largely uranium):

1. Gavin Mudd. Problems with in-situ Uranium leaching: <http://users.monash.edu/~gmudd/files/2000-TMW-AcidISL-Aus-USA.pdf>
2. Gavin Mudd: the case against Uranium in-situ mining: <http://users.monash.edu.au/~gmudd/files/1998-07-InSituLeach-UMining.pdf>
3. Gavin Mudd: critical review of acidic in-situ leaching of Uranium: <https://link.springer.com/article/10.1007/s002540100406>

4. NRC memo: <https://www.nrc.gov/docs/ML1417/ML14172A133.pdf>
5. GROUNDWATER RESTORATION FOLLOWING IN-SITU LEACH MINING OF URANIUM. University of NM, 2016:
http://digitalrepository.unm.edu/cgi/viewcontent.cgi?article=1140&context=ce_etds

C. References from the Wise Uranium website: this German website is an extraordinarily detailed non-profit compilation of scientific and newspaper documentation of the use of different technologies globally. It is updated to the extent that you will find all regulatory actions on in-situ uranium mines in the United States through 2017. If you are seriously interested in researching the history of the technology you could spend months reading their references....go to

<http://www.wise-uranium.org/uisl.html>

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- [Catchpole1995] Catchpole,Glenn; Kirchner,Gerhard: Restoration of Groundwater Contaminated by Alkaline In-Situ Leach of Uranium Mining. In: Merkel,B et al. (Ed.): Uranium Mining and Hydrogeology, GeoCongress 1, Köln 1995, p.81-89
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- [Mays1993] Mays,W M: Restoration of Groundwater at Three In- Situ Uranium Mines in Texas. In: IAEA (Ed.), Uranium in situ leaching. Proceedings of a Technical Committee Meeting held in Vienna, 5-8 October 1992, IAEA-TECDOC-720, Vienna 1993, p.191- 215
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- [Nigbor1982] Nigbor,Michael T; Engelmann,William H; Tweeton,Daryl R: Case History of a Pilot-Scale Acidic In Situ Uranium Leaching Experiment. United States Department of the Interior, Bureau of Mines Report of Investigations RI-8652, Washington D.C., 1982, 81 p.

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- [OECD1996] Uranium 1995 Resources, Production and Demand, OECD Nuclear Energy Agency/International Atomic Energy Agency (Ed.), Paris 1996, 362 p.
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Further Information

Video

- In-Situ Uranium Mining; Myth versus Fact , talk given by Dr Gavin Mudd on August 18, 2009, in Fort Collins, Colorado, USA, 50 min. (Flash player required)

Further Reading

- An Environmental Critique of In Situ Leach Mining: The Case Against Uranium Solution Mining , by Gavin Mudd, A Research Report for Friends of the Earth (Fitzroy) with The Australian Conservation Foundation, Victoria University of Technology, July 1998, 154 p.
- Acid In Situ Leach Uranium Mining - 1. USA & Australia , by Gavin Mudd, Paper presented at Tailings & Mine Waste '00, Fort Collins, Colorado, USA, January 2000. (PDF)
> Enlarged version in: Environmental Geology Vol. 41 (2001), p. 390-403
- Acid In Situ Leach Uranium Mining - 2. Soviet Block & Asia , by Gavin Mudd, Paper presented at Tailings & Mine Waste '00, Fort Collins, Colorado, USA, January 2000. (PDF)
> Enlarged version in: Environmental Geology Vol. 41 (2001), p. 404-416
- Guidebook on Environmental Impact Assessment for In Situ Leach Mining Projects , IAEA-TECDOC-1428, IAEA, Vienna, May 2005, 170 p. (2.5M PDF)
- Recent Developments in Uranium Resources and Production with Emphasis on In Situ Leach Mining , IAEA-TECDOC-1396, September 2004, 332 p. (4.8M PDF)
- Manual of acid in situ leach uranium mining technology , IAEA-TECDOC-1239, Vienna, August 2001, 283 p. (5.1M PDF)
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- Uranium Sequestration During Biostimulated Reduction and In Response to the Return of Oxidic Conditions In Shallow Aquifers , NUREG/CR-7178, U.S. NRC, Dec. 2014 (10.7MB PDF)
- Assessing the Potential for Bioremediation of Uranium In Situ Recovery Sites , NUREG/CR-7167, U.S. NRC, June 2014 (13.8MB PDF)
- Groundwater restoration at uranium in-situ recovery mines, south Texas coastal plain , by Susan Hall, U.S. Geological Survey Open-File Report 2009-1143, 2009, 32 p.
- Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities , NUREG/CR-6870, U.S. NRC, January 2007
- A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees , U.S. Nuclear Regulatory Commission, NUREG/CR-6733, Sept 2001, 200 p. (ADAMS Accession No. ML012840152)
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- Methods of Minimizing Ground-Water Contamination From In Situ Leach Uranium Mining (Final Report), by Deutsch, W J; Martin, W J; Eary, L E; Serne, R J, U.S. NRC (Ed.), NUREG/CR-3709, Washington DC, 1985, 88 p. (ADAMS Accession No. ML14224A350)
- Aquifer Restoration Techniques for In-Situ Leach Uranium Mines , by Deutsch, W J; Bell, N E, et al., . U.S. NRC (Ed.), NUREG/CR-3104, Washington DC, 1984, 55 p. (ADAMS Accession No. ML102560104)
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- Analysis of Groundwater Criteria and Recent Restoration Attempts After In Situ Uranium Leaching, by Buma, Grant; et al., (Open File Report). U.S. Bureau of Mines (Ed.), BUMINES-OFR-90-82, Washington DC, 1981, 305 p.

Industry Information

- Wyoming Mining Association (WMA) , USA
- Uranium Information Centre (UIC) , Australia
- In situ leaching method of extracting uranium , Appendix 1.1 of the Report of the Senate Select Committee on Uranium Mining and Milling, Canberra, Australia, May 1997
- Crow Butte (Cameco)